U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 926

SOME COMMON DISINFECTANTS

THE word "infected" means contaminated with or affected by disease germs; "disinfected" means freed of disease germs. A "disinfectant" is a product that destroys disease germs or renders them harmless. An "antiseptic" is a substance that prevents the development and growth of disease germs, but an antiseptic is not a disinfectant unless it is capable of destroying disease germs in addition to preventing their growth.

A disinfectant is not necessarily an "insecticide," for some powerful disinfectants are relatively harmless for insects and good insecticides may be of little value as disinfectants.

Formaldehyde is a powerful disinfectant, but it is a very weak insecticide; and, conversely, hydrocyanic acid is deadly for insects and all forms of animal life, while it has little power as a germicide or disinfectant. It is well to remember also that "deodorants" are not necessarily disinfectants—one destroys odors, the other destroys germs.

No single disinfectant is appropriate in all cases. Select the proper substance, apply liberally, allow ample time for the disinfectant to do its work, and remember that success depends in large part upon the care and exactness of the person who prepares and applies the disinfectant.

This bulletin is a revision of and supersedes Farmers' Bulletin 345.

Washington, D. C.

Issued March, 1918,
Revised May, 1931

SOME COMMON DISINFECTANTS

By M. DORSET, *Chief of Biochemic Division, Bureau of Animal Industry*

CONTENTS

NEED OF INFORMATION ABOUT DISINFECTANTS

THERE is much popular misconception regarding the value and limitations of disinfectants. The efficacy of disinfectants is largely dependent upon the mode of application and the kind of material to which they are applied; therefore some knowledge of disinfectants and of their limitations is necessary to obtain the desired results.

In this bulletin no attempt is made to cover the entire field, but rather to indicate briefly the properties and uses of some of the disinfectants that are commonly used about the household and the farm.

FORMALDEHYDE

Formaldehyde, also called "formic aldehyde," may be obtained on the market in two forms. The one, a sort of condensed formaldehyde, is known as "paraform," and is sold as a white powder or in the form of compressed tablets or pastils. The other is a strong solution of formaldehyde in water and is generally known under the name of "formalin," or solution of formaldehyde. The solution contains from 37 to 40 per cent of formaldehyde.

For practical disinfection the formaldehyde is applied either in the form of gas or vapor or in solution in water. It is most commonly used in gaseous form.

FORMALDEHYDE GAS

Gaseous formaldehyde rather than the solution of formaldehyde is commonly employed in cases where the furniture or interior decorations of rooms would be injured or where the value of materials, such as hay and fodder, would be lessened by wetting. In disinfecting with formaldehyde gas it is essential that a sufficient quantity of

50543°—31

gas be liberated and that it be held within the compartment that is to be disinfected for a sufficient length of time to accomplish the destruction of the germs of disease. The gas escapes very readily through any openings or crevices around windows, doors, or elsewhere. Hence it is essential that compartments to be disinfected by formaldehyde gas be tightly closed and that all openings be sealed during the period of disinfection. It is well to remember also that the temperature is an important factor in disinfecting with gaseous formaldehyde, as this disinfectant is much more energetic in a warm than in a cold atmosphere. If the temperature is much below 65° F. disinfection with gaseous formaldehyde can not be relied upon under ordinary circumstances. It is desirable also that the air be moist, and precautions in this respect should be taken in dry weather. In cold weather compartments should be heated.

Various forms of apparatus have been designed for generating formaldehyde gas. Some of these produce the gas from wood alcohol; others are designed to liberate gas by heating solid formaldehyde (paraform), while still others merely volatilize the formaldehyde solution. Although these various methods are effective, they require special generating apparatus and are no more effective than simpler means which have now generally replaced the more expensive and complicated processes. The two methods most generally used for applying formaldehyde gas are the spray method and the potassium permanganate method.

SPRAY METHOD

The spray method is best suited for use in small compartments, such as chests and closets. The commercial 40 per cent solution of formaldehyde is used. This is sprayed directly into small chests and closets, and in the case of small rooms the solution is sprinkled upon a sheet which has been suspended in the room for the purpose. An ordinary sprinkling can, such as is used for watering flowers, may be used for spraying the solution of formaldehyde. At least 10 ounces of the solution should be used for each 1,000 cubic feet of space in the room. After spraying the formaldehyde the room or compartment should be quickly closed, keyholes and apertures sealed, and allowed to remain so for at least eight hours.

POTASSIUM PERMANGANATE METHOD

The potassium permanganate method has now come into quite general use for disinfecting rooms and large compartments. It is carried out by pouring 40 per cent solution of formaldehyde upon crystallized or powdered potassium permanganate. A violent chemical reaction takes place immediately. Heat is generated and formaldehyde in gaseous form is rapidly liberated. The heat is caused by the reaction between the formaldehyde and the potassium permanganate, and a considerable proportion of the formaldehyde is consumed by this reaction. It has been found that the quantity of gas evolved depends in great measure upon the relative weights of permanganate and of formaldehyde solution that are used. Experiments have shown that the most favorable proportions are 6 parts

by weight of 40 per cent formaldehyde solution to 5 parts by weight of chemically pure permanganate of potash. With these proportions approximately 50 per cent of the formaldehyde is liberated in the form of gas.

Allowance must be made for the loss of formaldehyde, owing to the chemical reaction, when arranging for disinfection by this method. As approximately 10 ounces of formaldehyde solution is required for the disinfection of 1,000 cubic feet of space, it is necessary when this method is employed to use twice as much. In practice, therefore, for disinfecting 1,000 cubic feet of space, use 20 ounces of formaldehyde solution by weight to 16⅔ ounces of potassium permanganate. The needle-shaped crystals of the permanganate should be employed.

To disinfect a room, place the required quantity of permanganate in a wide-bottom bucket or basin with flaring sides. An ordinary dish pan will serve the purpose well. The pan should be raised a short distance from the floor by means of a box or bricks to prevent injury to the floor from the heat, and it is desirable also to protect the floor for some distance around the pan by means of paper or otherwise, as sputtering during the reaction may cause some of the chemicals to splash entirely out of the container. This is less likely to occur if the vessel has good depth.

When everything has been made ready the requisite quantity of 40 per cent formaldehyde solution should be poured upon the permanganate, which should have been previously placed in the container, and the room should then be quickly closed and sealed. It should remain closed for at least eight hours, and a considerably longer period is better in order to assure thorough disinfection. It should be remembered that formaldehyde gas does not penetrate deeply into articles; that it will not quickly enter bureau drawers, closets, and other compartments within the room unless they are opened wide and arranged so that the gas may have free access to them. The same applies to clothing and draperies, which should be hung loose and free in the room. Crevices and cracks around windows, doors, and elsewhere are most conveniently closed by pasting strips of paper over them. All openings into the room should be thus closed except the one through which exit must be had after starting the disinfection. The crevices about the exit can be closed as above indicated after retiring from the room.

FORMALDEHYDE SOLUTION

Solution of formaldehyde is a most excellent and reliable disinfectant. For general purposes it is best used by making a 10 per cent solution in water; that is, 10 parts of the 40 per cent solution of formaldehyde made to 100 parts with water. Small objects which will not be injured by wetting may be immersed in the solution. It does not affect metals injuriously except after prolonged action. It is an excellent deodorant as well as a disinfectant and may be usefully employed for disinfecting small areas around the house or stable, for disinfecting discharges from the sick room, and in numerous other ways. It tends to harden skins and render them brittle and is, therefore, not suited for the disinfection of furs, but ordinary fabrics are not injured and it usually has little effect upon colors.

ADVANTAGES AND DISADVANTAGES OF FORMALDEHYDE

The advantages of formaldehyde may be summarized as follows:

It is a powerful germicide.

Its action is not hindered greatly by albuminous substances or organic matter.

It is relatively not very poisonous.

It is not injurious to delicate fabrics, to paint, or to metals. (Prolonged contact will affect iron but not other metals.)

It is the only known gaseous disinfectant which can be used effectively and safely in households.

The disadvantages of formaldehyde are as follows:

The gas has a strong tendency to condense in cold weather, and it is not reliable as a disinfectant when the temperature of the air is much below 65° F.

It has a very penetrating odor, and the gas is irritating to the eyes and nose.

To accomplish disinfection by the gas a long period of exposure is necessary and considerable work is required in the proper sealing of rooms which are to be disinfected.

CARBOLIC ACID (PHENOL)

The term "carbolic acid" has been rather loosely employed to designate a variety of substances which, though related chemically, are yet very different in their disinfecting properties. The true carbolic acid, or phenol, as it is more properly termed, when in a pure state is solid at ordinary temperatures and when freed of water crystallizes in long white needles. Owing to their property of absorbing water from the air the crystals are likely to form a solid cake in bottles and other containers. For this reason carbolic acid is usually dispensed from drug stores in a liquid form prepared by adding 1 part of water to 9 parts of the crystals. The pure carbolic acid is not well suited for disinfection on a large scale on account of its cost. It is also not so powerful as other disinfectants which may be obtained at a smaller cost.

A 5 per cent solution of pure carbolic acid is a very satisfactory disinfectant for sputum or for discharges from the sick room, and a 2 per cent solution for disinfecting the hands. Fabrics may be disinfected by immersion in a 5 per cent solution for one hour. Carbolic acid does not seem to have the power of killing the germs of certain diseases, such as smallpox and hog cholera, but for most of the ordinary bacteria it is very effective. Large surfaces are best treated by spraying with a 5 per cent solution. Neither carbolic acid nor other related disinfectants, such as crude carbolic acid, cresol, etc., are suitable for use in refrigerators or compartments where foods are stored nor in barns where dairy cows are kept, for the reason that all food products tend to take up carbolic acid from the air and acquire a disagreeable taste and odor which renders them unfit for food. It should be remembered, likewise, that carbolic acid is one of the most virulent of poisons, and that it is dangerous to leave it around the house in concentrated form.

ADVANTAGES AND DISADVANTAGES OF CARBOLIC ACID (PHENOL)

The advantages of carbolic acid are:

It is reasonably effective for destroying most of the common bacteria.

Its action is not greatly hindered by organic matter.

In a 5 per cent solution it does not materially injure metals or fabrics after contact for one hour or less.

It is readily available at all drug stores.

The disadvantages are:

It is not effective against all forms of bacteria.

It is expensive.

It is very poisonous.

The strong odor is absorbed by foods.

CRESOL

Cresol is found on the market in varying degrees of purity. It is known also under a variety of names, such as tricresol, cresylic acid, liquid carbolic acid, straw-colored carbolic acid, etc. It is a clear, oily liquid and varies in color from light straw to a rather deep reddish brown. It has a strong odor resembling that of pure carbolic acid, and like carbolic acid is very corrosive when in concentrated form.

The cresol of commerce consists of a mixture of closely related bodies, all of which are superior to pure carbolic acid as disinfectants. It differs from "crude carbolic acid" in being practically free of coal-tar oils. Commercial grades usually contain from 90 to 98 per cent of cresylic acid or tar acids, and they may be purchased under guaranty of a definite degree of purity. Grades which contain less than 90 per cent of cresylic acid are not so desirable as those of greater purity, for coal-tar oils, generally found in the less pure grades, interfere with the solution of the cresol in water. Under ordinary market conditions cresol is relatively cheap and therefore well suited to the disinfection of cars, barns, and yards. Cresol may be used in the same way as pure carbolic acid, though it is considerably more powerful as a disinfectant and is therefore employed in a weaker solution. Roughly a 2 per cent solution of cresol may be regarded as equivalent to a 5 per cent solution of pure carbolic acid.

In preparing solutions of cresol, allowance should be made for the impurities. Cresol is not readily soluble in water; therefore warm water should be used in making solutions and care should be taken to see that all cresol is dissolved before the disinfectant is used. Cresol is very poisonous, though less so than pure carbolic acid. Although cresol is a more effective disinfectant than carbolic acid, its difficult solubility is a rather serious drawback; therefore, compounds of cresol with soap, which are readily soluble, are better than pure cresol for household and farm use. Many mixtures of cresol with soap are on the market under a variety of names.

COMPOUND SOLUTION OF CRESOL

The compound solution of cresol is described in the United States Pharmacopœia. Any drug store should be able to provide it. It is

a mixture of cresol with a soap made of linseed oil, potash, and soda. This compound solution of cresol is a thick, clear, brown fluid which mixes readily with soft water in all proportions to form a clear, soapy solution. It does not mix well with hard water because the mineral salts in the hard water cause the soap to break up and separate into sticky masses. Compound solution of cresol is used in a 2 or 3 per cent solution.

A very efficient substitute for the compound solution of cresol may be made from U. S. P. cresol by mixing it with ordinary green soap, which is purchasable at all drug stores. The green soap is dissolved directly in the cresol, using equal parts of cresol and green soap by weight. The cresol is warmed and the soap stirred in until it is thoroughly dissolved.

Substitutes for compound solution of cresol are prepared and sold by companies dealing in disinfectants. The concentrated disinfectant when purchased already prepared should, if of good quality, be entirely homogeneous in composition. It should be readily and completely soluble in cold, distilled water, and the solution should be practically clear and contain no globules of undissolved oil or cresol. The United States Bureau of Animal Industry requires compounds of this nature, which are to be used in the official disinfection of cars, boats, and stockyards, to conform to very definite standards of composition and solubility. For official use a permitted saponified cresol solution is usually diluted in the proportion of 4 ounces in 1 gallon of water.

ADVANTAGES AND DISADVANTAGES OF COMPOUND SOLUTION OF CRESOL

The advantages are:

Weight for weight it is much more efficient and is cheaper than pure carbolic acid.

It is effective against hog cholera, whereas pure carbolic acid is ineffective.

It is very readily soluble.

Its soapy character permits good contact with greasy surfaces.

The disadvantages are:

It can not be used in or near compartments where foods are kept, because of its odor.

It does not mix well with hard water.

It is poisonous, though much less so than carbolic acid.

CRUDE CARBOLIC ACID

Crude carbolic acid is a dark, oily fluid that is obtained during the distillation of coal tar, and usually contains little or no true carbolic acid. It has been widely used in this country as a household and farm disinfectant. Essentially, crude carbolic acid is a mixture of oils and "tar acids."

There is little to be said in favor of the use of crude carbolic acid as a disinfectant. Its composition is generally uncertain, and it possesses no advantages over other disinfectants, which, considering their power and their ready availability, are to be preferred.

EMULSIFIED COAL-TAR DISINFECTANTS

The emulsified coal-tar disinfectants are found widely distributed on the market and are sold in cans or bottles of different sizes under a great variety of trade names. They are prepared from coal-tar products and consist of coal-tar oils and tar acids with soap. The product as purchased is a very dark, thick fluid, which should be of uniform consistency throughout. When mixed with water a milky emulsion is formed.

The disinfecting power of the products on the market varies greatly. There is no trustworthy method of determining their relative values by chemical analysis, so a method of comparing them by tests on typhoid-fever germs has been worked out. The power of carbolic acid to kill these germs under certain conditions is worked out in the laboratory, and after tests of the emulsified coal-tar disinfectants have been made under the same conditions their disinfecting power is expressed in the form of a comparison with carbolic acid. This is called the "carbolic-acid coefficient." If the coal-tar disinfectant is five times as effective as carbolic acid, it is said to have a carbolic acid coefficient of 5. As a matter of fact, some of these preparations have a coefficient of only 0.5, while others have a coefficient of 20. The user of these products will do well to purchase only those that have a guaranteed carbolic-acid coefficient.

At the same time it should be borne in mind that the carbolic-acid coefficients are determined in the absence of organic matter. Most disinfectants, however, are actually applied in the presence of organic matter (manure, blood, and dirt of any kind) which impairs the efficiency of the disinfectants against bacteria. The emulsified disinfectants suffer much greater loss in efficiency than solutions of phenol so that under the conditions of practical use the carbolic-acid coefficient does not accurately indicate the relative values. In general, the higher the coefficient the greater the allowance that should be made for the adverse effect of organic matter. In the presence of organic matter the emulsified disinfectants may usually be effectively employed at a concentration twice as great as would be indicated by the coefficient.

In general these emulsified coal-tar disinfectants have the same uses and properties as carbolic acid and compound solution of cresol, though they are less poisonous than either.

LIME

Ordinary quicklime is one of the best and cheapest of disinfectants. It is not commonly applied in the form of quicklime, but in the form of a thick mixture with water known as "milk of lime." The lime is first slaked by adding 1 pint of water to 2 pounds of quicklime. Considerable heat is generated by this mixture, owing to a chemical union of the lime and the water, which forms the hydrate of lime, or water-slaked lime. The development of heat and the crumbling of the hard lumps of quicklime are indications that the lime is of good quality and that it will make a satisfactory milk of lime.

The milk of lime is obtained by adding 4 volumes of water to 1 of the slaked lime and mixing thoroughly. Lime that has been exposed to the air for a long time becomes air slaked; that is, it takes up

moisture and carbonic acid from the air and is converted into carbonate of lime, which is the same as marble and almost totally worthless as a disinfectant. After quicklime has been slaked with water, the slaked lime and any stock solution of milk of lime that may have been prepared should be kept in tightly closed containers to prevent deterioration, which will result from the action of the air. Whitewash is prepared by adding water to milk of lime until a mixture of suitable density is obtained.

Quicklime may be scattered about yards and lots, and the milk of lime is a good disinfectant for sick-room discharges. It should be added to urine or excreta in liberal quantity and allowed to remain in contact with these discharges for two hours before they are disposed of. Whitewashing of fences, pens, and the interior of outhouses serves to render them more sanitary as well as more attractive in appearance. Lime is well suited for use about dairy barns on account of the lack of any odor. It is preferable to chlorinated lime for that reason.

The advantages of lime as a disinfectant consist in its ready availability and cheapness. It is not, however, a reliable disinfectant against the most resistant forms of germ life, such as the spores of the anthrax bacillus.

LYE

Ordinary lye, known also as caustic soda and sodium hydroxide, is readily obtained in 1-pound metal containers. The essential ingredient for disinfection is the sodium hydroxide, which usually constitutes about 94 per cent of the total weight. Recent investigations have shown that sodium hydroxide is perhaps the most effective of all disinfectants against foot-and-mouth disease of cattle. It is very effective against the germs of typhoid fever of man and also against those of fowl cholera and bacillary white diarrhea of young chicks. This chemical, even in strong solutions, is not effective against the germs of tuberculosis. For general disinfection a 2 per cent solution in water is recommended. To prepare such a solution 1 pound of commercial lye containing 94 per cent of sodium hydroxide is dissolved in 5½ gallons of water. The lye should be completely dissolved and the solution well mixed before using. The lye should be taken only from a container that has not previously been opened or from one which has been kept tightly closed. Exposure of the lye or lye solutions to the air leads to the conversion of the sodium hydroxide into a carbonate which is much less effective as a disinfectant. In cases where lime is not objectionable the addition of 2½ pounds of water-slaked (not air-slaked) lime to the 5½ gallons of lye solution to form a whitewash will at the same time prevent the transformation of the hydroxide into carbonate. A whitewash made in this way is not suitable for all purposes because of the action of the alkali upon certain materials, as explained below. Concentrated lye is a caustic poison. Care should be taken to avoid introducing any of it into the eyes and to avoid breathing any of the fine dust that may arise from handling the dry substance. Solutions should be so disposed of as to prevent injury to livestock.

The advantages of lye as a disinfectant are that it is cheap, odorless, and effective against the germs of certain diseases named above. The disadvantages are that the concentrated material is a caustic poison—even weak solutions are injurious to painted and varnished surfaces as well as to aluminum and fabrics, if allowed to remain in contact with them for a considerable period of time; repeated application of solutions of sodium hydroxide will gradually soften and remove the glaze on ordinary enamelware.

CHLORINE DISINFECTANTS

CHLORINATED LIME

This substance is commonly known also as "bleaching powder" or "chloride of lime." It is a white powder that gives off the disagreeable odor of chlorine. It should be kept in hermetically sealed containers, as exposure to the air causes it to deteriorate rapidly. The efficacy of chlorinated lime is largely dependent upon the quantity of available chlorine that it contains. The United States Pharmacœpia requires that at least 30 per cent of chlorine should be present in available form.

Although chlorinated lime is a very powerful disinfectant, its potency is immediately and greatly reduced when it is brought into contact with organic matter. This is because the available chlorine combines quickly with the organic matter and is thus diverted from its desired action upon the germs. In applying chlorinated lime to the disinfection of sick-room discharges, manure, etc., it is important to add it in considerable excess so as to make allowance for the chlorine that will be used up by the organic matter. Besides being a good disinfectant, chlorinated lime is a powerful deodorant.

Chlorinated lime is only partly soluble; therefore in preparing it for use it is well first to rub it up well with a little water so as to break up the lumps, finally diluting to the desired volume. For general household and farm use, 6 ounces of chlorinated lime are mixed with 1 gallon of water.

OTHER CHLORINE DISINFECTANTS

Besides chlorinated lime, other similar chlorine compounds have come into more or less general use in recent years. Sodium hypochlorite, which is usually sold in solution and under various proprietary names, has been extensively used to disinfect dairy equipment, such as milk cans and bottles and conveying pipes in creameries. This compound, in the concentrations usually employed, is effective when applied to perfectly clean surfaces, but, like chlorinated lime, its efficiency is largely reduced in the presence of organic matter.

The uses to which chlorine disinfectants may be put are restricted because of corrosive action and their odor. They are powerful bleaching agents and corrode metals. The odor is apt to be absorbed by meat, milk, and other food, and for these reasons the use of chlorine disinfectants is not recommended about ice boxes, cellars, or compartments where food is stored or in dairy barns. The chlorine disinfectants are not effective against the germs of tuberculosis.

BICHLORIDE OF MERCURY

Bichoride of mercury is known also as "mercuric chloride" and "corrosive sublimate." It is usually sold in the form of tablets, in which the bichloride of mercury is combined with ammonium chloride, which facilitates solution in water. The bichloride has long been known to be a very powerful disinfectant. However, its power is greatly reduced when it is applied to solutions or substances containing large quantities of organic matter. Bichloride of mercury is included with other common disinfectants in this bulletin more for the purpose of a warning against its use than for recommending it. It is extremely poisonous and therefore dangerous to have about the house. Many accidents have occurred through its use. It is not nearly so effective or so satisfactory for household use as many of the other disinfectants already described. It tends to attack metals. For these reasons it is not to be recommended as a household disinfectant.

U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents